REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

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1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
9/30/2009	Final report	01/01/2007 - 06/09/2009

4. TITLE AND SUBTITLE

Planning and CONOPS
review for NSW coastal oceanography experiments

5a. CONTRACT NUMBER

5b. GRANT NUMBER

N00014-07-1-0343

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Terrill, Eric

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Marine Physical Laboratory of the Scripps Institution of Oceanography
University of California, San Diego
291 Rosecrans Street
San Diego, California 92106

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Office of Naval Research
One Liberty Center
875 N. Randolph Street, ONR 32
Arlington, VA 22203-1995
Theresa Paluszkiewicz

10. SPONSOR/MONITOR'S ACRONYM(S)

ONR

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

Distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The long term goals of this program, funded under ONR grant N00014-07-1-0343, are to identify ocean science and sensor development issues of relevance to Naval Special Warfare maritime operations.

15. SUBJECT TERMS

coastal oceanography, ocean technology, forecasting

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Anne J. Footer
Unclassified	Unclassified	Unclassified	None	4	19b. TELEPHONE NUMBER *(Include area code)* 858-534-1802

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Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18

Contract Information

Contract Number	N00014-07-1-0343
Title of Research	Planning and CONOPS review for NSW coastal oceanography experiments
Principal Investigator	Eric Terrill
Organization	Scripps Institution of Oceanography

Technical Section

Technical Objectives

The long term goals of this program are to identify ocean science and sensor development issues of relevance to Naval Special Warfare maritime operations.

Naval Special Warfare (NSW) operations are greatly aided by accurate and timely meteorological and oceanographic (METOC) data and forecasts. Unfortunately, regions of naval interest can be data poor, introducing gaps of knowledge which can only be met through placement of environmental sensors and dependence on environmental models that have unknown accuracies when used in new coastal regions. In addition, environmental sensor data and environmental model outputs are perishable when used for operational decision making, placing requirements on the need for tools to conduct timely synthesis of METOC information.

Technical Approach

Our approach to this program were to

a) Assess needs of navy METOC and NSW community for oceanographic and meteorological information when developing concept of operations.
b) Identify new and existing technologies that may assist NSW METOC needs. Technologies may include, but are not limited to: new sensors, sensor platforms, underwater vehicles, data telemetry techniques, and software tools for data fusion and visualization.
c) Conduct nearshore observations of the physical characteristics of coastal San Diego. Assemble coastal data sets where needed to evaluate and validate the performance of the Delft 3D ocean model nearshore datasets where needed. This ongoing work, done in conjunction with Deltares, Batelle Pacific Northwest National Laboratory, and Cal Poly San Luis Obispo.
d) Continue the development of an A-size sonobouy form factor acoustic listening system.

WORK COMPLETED

Technology demonstrations and review with the METOC community:

The approach used with this program was to continue to meet with both officers and senior enlisted within the NSW METOC communities. Demonstrations of oceanographic sensors, visualization techniques, and modeling capabilities were provided to METOC at the amphibious base in Coronado, SDVT1 Honolulu HI, and SDVT2 Little Creek. In addition, weather support staff for Marines located at Camp Pendleton were engaged on issues that shared relevance with NSW operations. An unplanned result of this effort was improvement between USMC METOC and NSW METOC communications for theaters in which both have operations (eg – Operation Iraqi Freedom and Operation Enduring Freedom).

As a result of these discussions, two sensing gaps have been identified:
1. Robust, unattended weather stations that provide aviation quality data
2. Reliable and cost effective directional wave buoys that can be used an expendable drifters.

As a result of identifying these sensor gaps, Scripps is now sponsored by ONR (a separate grant) to develop technologies to fill these gaps. The developments include the Expeditionary Meteorological System (XMET) for the USMC METOC community and the Miniature Wave Buoy for testing with the NSW METOC community. Both systems will be tested in environments consistent with fleet needs, and results will be reported the fleet.

Nearshore Observations and Modeling:

To assess the fidelity of finescale oceanographic model in the nearshore environment, ONR sponsored the Coastal River Project (CRP). The CRP involved participants from Deltares, Cal Poly San Luis Obisbo, Batelle Pacific Northwest National Laboratory (PNNL) and Scripps. To provide focus for the assessment, a study of the fate and transport of the Tijuana River plume in the San Diego region is being conducted. Both a combination of modeling using Delft3D, Delft Hydraulics, and analysis of observation data is underway. The Tijuana River plume presents an ideal test case for this study, with real-world applications to naval training taking place at the amphibious base located 12 km to the north in Coronado, with a high potential for swimmers to be exposed to plume water. The Tijuana River is characterized by a 1700 square mile, binational watershed, 2/3 which exists within Mexico and contains over a million inhabitants, many with poor sewer infrastructure. The watershed drains into the Tijuana Estuary, and discharges into the ocean approximately 2.5 km north of the U.S. – Mexico border. While small, dry weather flows have been known to happen (through infrastructure failures or illegal dumping), the discharge dramatically increases during rainfall, with recorded discharge rates of 5-10 m^3/s occurring during storms with rainfall rates of approximately 2-5 mm/hr. The characteristics of the watershed result results in a river plume containing a high level of human pathogens and other contaminants.

The Delft3D FLOW module, a sigma coordinate hydrodynamic model that allows tidal and meteorological forcing, has been implemented with an advection-diffusion solver to track the river plume. The performance of the model is being tested through the analysis of observational

data sets gathered by an array of surface current mapping HF radar, a network of meteorological sensors, in-water sensors deployed near Imperial Beach, and satellite remote sensing imagery.

Surveys using the REMUS AUV were conducted in 2008 and 2009 post-storm events. Those data have been used to constrain the DELFT model. Results from the modeling and observational approach were reported at the ONR review in Chicago (June 2009) and at the ONR site visit to Deltares (August 2009).

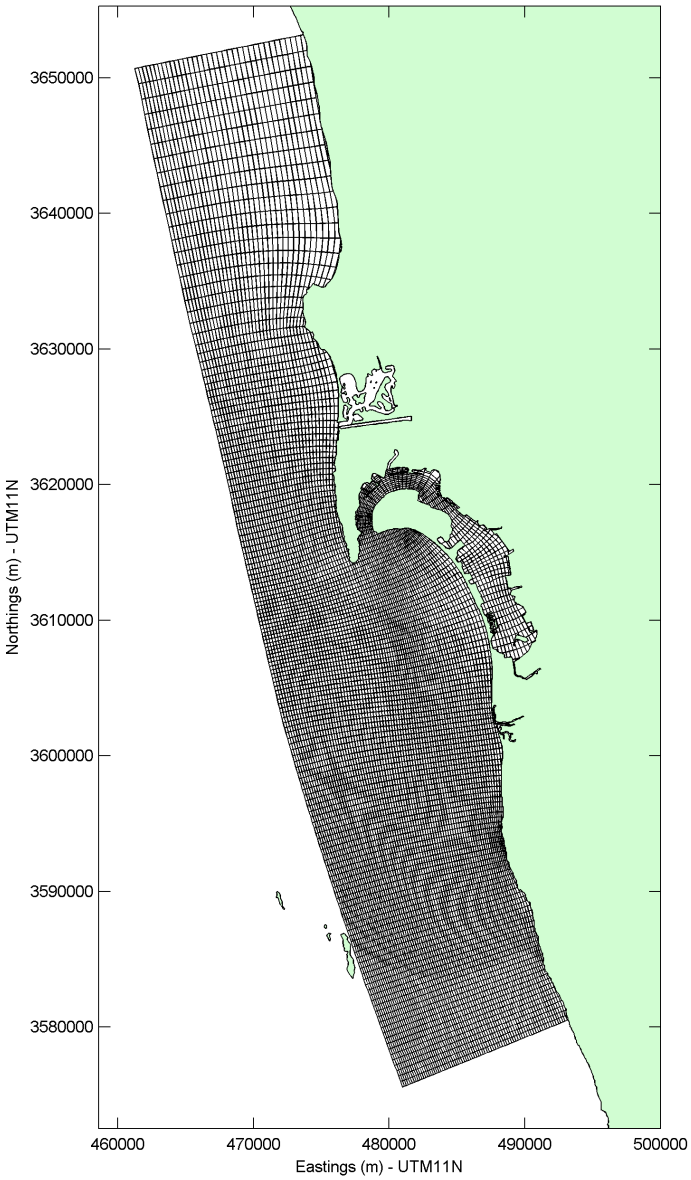

Figure 1. The Delft 3D Model domain used for assessing model performance and for the development of assimilation techniques for REMUS AUV based observation.

Acoustic Sensor Development

Use of passive acoustics to characterize seastate, rainfall, and ship traffic is a fleet interest. Through this grant, Scripps has continued the development and improvement of an ambient sound recording system. Our engineering efforts this past year have focused on a) reducing the power consumption of the system b) developing software to speed the processing of data once the system is recovered c) package the system into an A-size sonobuoy form factor.

The ambient noise recording module consists of a broadband hydrophone (100 kHz bandwidth), a signal conditioning board, a high speed a/d board capable of sampling up to 190 kHz, and a DSP board for computing broadband acoustic spectra. All data sets are controlled and recorded by a Motorola 68332 based embedded microcontroller, with data written to compact flash. As a result of this grant, we have developed a self-recording version of the system that is 4 7/8" diameter x 30". When powered by primary lithium batteries, the system can operate continuously for 30 days. A pressure sensor is also integrated into the system so that the depth of the sensor can be tracked in time. We anticipate building a small array of sensors and conducting tests with the system through separate ONR funding.

Figure 2. Self-recording ambient sound system. The A-size sonobouy form factor can operate unattended for 30 days using primary lithium batteries.